Buying fans? Compare the right facts

Airflow data might not tell whole story

By Dr. Doug Overhults
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That flashy piece of ventilation fan sales literature from the last trade show touts a marvelous new blade, housing and shutter design that "delivers one of the best airflows in the industry." Yes, right there on the front page is some impressive airflow data. And the price you jotted down seems lower than some others you have seen. This fan looks perfect for your latest building project — a barn that needs a lot of ventilation. Case closed — time to move on to the next item.

Well, maybe it's time to slow down a bit! Let's take a closer look and dig a little deeper before placing the order. Take that airflow data, for example. It doesn't say whether the shutters and guards were in place for those tests. When accessories are included, it's usually noted with the performance data, so they probably weren't installed when the test was done. Airflow could go down 10 to 20 percent when shutters and guards are added. If you were planning to install 10 fans to meet the design ventilation rate, you could end up being a couple of fans short.

Conspicuously absent from the test data is any information about power consumption. Thus, there is no way to project an operating cost for the fans. We could look at some other fan literature and assume all fans of this size use about the same electrical energy, since nearly all of them seem to have the same motor nameplate horsepower. Unfortunately, the logic sounds good, but it turns out to be a really bad assumption!

The best way to select fans is by considering only "rated" fans. Fans are rated when they are run through a series of standardized performance tests by a certified laboratory. The BESS lab at the University of Illinois (see sidebar, page 42) is one such lab that routinely measures airflow performance with all of the guards, shutters, discharge cones or other accessories in place as the fan would be installed in a building. Data from their tests provide all of the information needed to evaluate different sizes and brands of fans.

Since the procedures are standardized and the tests are done to mimic "as installed" conditions, using BESS lab data is a very good way to make an apples-to-apples comparison between two or more fans.

Certainly airflow delivery, usually reported as cubic feet per minute at the specified operating static pressure is a primary criteria for choosing an appropriate fan. Using data from the BESS lab tests, it becomes very clear that airflow performance for the same diameter and horsepower fan varies widely. The performance curves in Figure 1 show the difference between the best and worst 48-inch fans tested. At a static pressure of 0.10 inches of water, the best fan delivers two times as much air as the worst fan. Obviously, just specifying a 48-inch, 1 horsepower fan gets you nowhere in terms defining air delivery capability.

Even though the quantity of air delivered is number one on the list of selection criteria, it is not the only important item to review. What wasn't considered in the opening scenario, and is overlooked far too often, is the cost to operate the fan after it is installed. It turns out that ventilation fans, especially those that operate a lot of hours, can cost several times more to operate than the initial purchase price. So, energy-efficient delivery of the desired airflow is also an important consideration. Fan test data should include the Ventilation Efficiency Ratio (VER) or "cubic feet per minute per Watt" rating (see sidebar, page 42) at each static pressure used in the test. Like airflow delivery, the VER can vary substantially among brands of the same size fan and among models from the same manufacturer. Some VER guidelines for different size fans are given in Table 1.

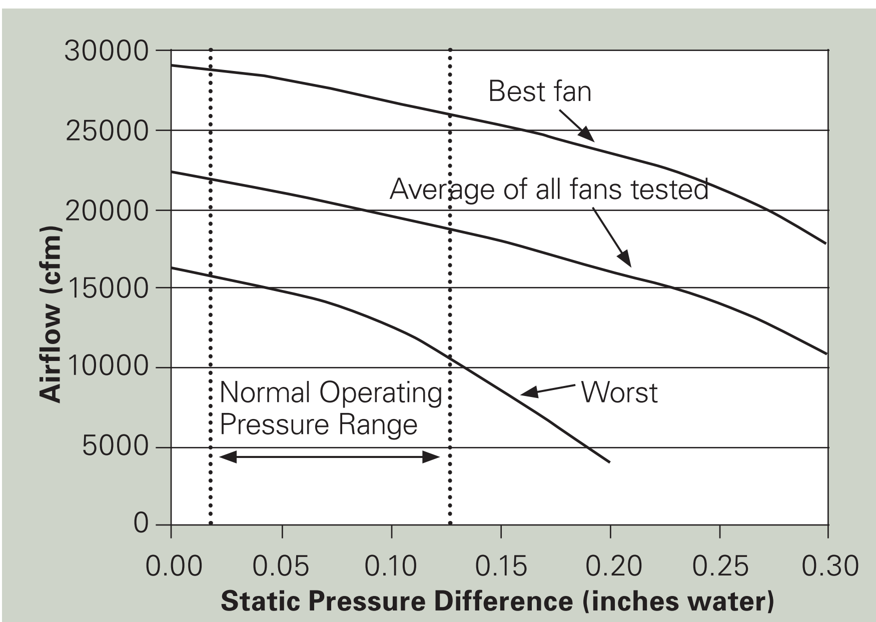

Figure 1. Airflow delivery for the best and worst 48-inch fans with 1 hp motors (BESS lab test data)

Using fan test data

Try this example to see how fan test data can be used and to illustrate why fan efficiency is so important.

Suppose a ventilation design requires an installed airflow delivery capability of 235,000 cubic feet per minute at 0.10 inches of water static pressure. Two reputable manufacturers have 48-inch fans with similar features and construction. Both brands also have the same motor horsepower and similar airflow performance capability. According to the BESS lab test results shown in Figure 2, Fan A provides 24,300 cubic feet per minute and Fan B delivers 24,200 cfm at 0.10 inches of water static pressure with all accessories included. However Fan A costs only $800 per unit while Fan B costs $1,100. Which fan should you choose?

At first glance this choice seems like a no-brainer. Selecting the cheaper fan meets the airflow criteria and saves $3,000 on the 10 fans that would be needed. So, why not take Fan A, save the customer some money, and maybe underbid your competitor?

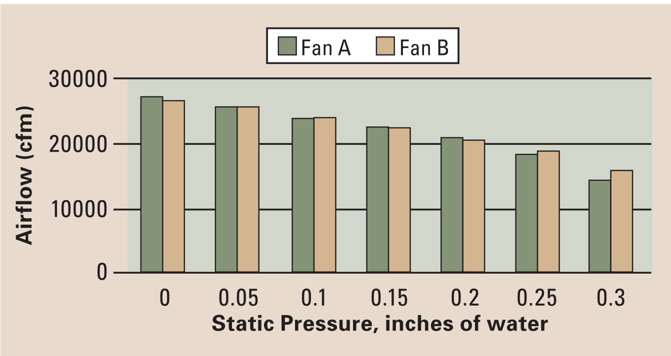

Figure 2. Airflow performance for two brands of 48-inch, belt drive ventilation fans with as installed accessories in place.

Answering this question requires that missing piece of the puzzle known as the VER. The VER, expressed as cfm per watt, allows us to calculate a projected operating cost and compare the costs of operating our two example fans. This comparison can be very significant since the long term operating cost may be much larger than the fan's initial purchase price.

TABLE 1.
VER (cfm per Watt) guidelines for different fan sizes at 0.10 inches of water static pressure

FAN DIAMETER [INCHES]	MINIMUM	SUGGESTED
24	12	14
36	16	18
48-52	18	20
54-55	20	22

Figure 3 shows the fan efficiency (or VER) for Fans A and B at each test static pressure. At 0.10 inches of water, the VER for Fan A is 15.3 cubic feet per minute/

Finding Fan Test Data

The BESS Laboratory in the Agricultural & Biological Engineering Department at the University of Illinois measures airflow performance from many agricultural ventilation fans. Their equipment and test procedures meet industry accepted standards and tests are performed with shutters, guards and other accessories in place as the fan would be operated in a building. Their test results provide unbiased engineering data that is appropriate for building design and fan comparisons.

The lab tests only fan models submitted by manufacturers, so not all brands and models of fans are tested. However, data is available for more than 800 commercially available fans that range in size from 8 to 54 inches in diameter.

Test results can be accessed online through the BESS lab web site: http://www.bess.uiuc.edu. Published test results are also available in a book titled "Agricultural Ventilation Fans — Performance and Efficiencies" at a cost of about $15 from these two sources:

- National Food & Energy Council
www.nfec.org (click on materials to order)

- Midwest Plan Service
www.mwpshq.org (click on ventilation)

Ventilation Efficiency Ratio

As fans are tested for airflow delivery at specified static pressures, electric power used by the fan motor is also measured. When the airflow is divided by the power demand, the result is called the Ventilation Efficiency Ratio or VER and has the units of CFM (cubic feet per minute) per Watt. A VER is calculated for each static pressure used in the test.

Since the VER includes a power measurement, it is obviously going to be affected by the motor and drive system. However, it can also be affected by just about all of the fan design features and installed accessories as well. As with the airflow performance, it is important to look at VER test results which are representative of an "as installed" fan, including the motor and drive normally sold with the fan.

In general, VER increases as fan diameter increases. For an individual fan, VER decreases as static pressure increases.

Watt and the VER for Fan B is 20.4 cubic feet per minute/Watt.

To calculate annual operating cost we also need to know the expected hours of operation and the cost of electrical energy. If we assume the fan operates 4000 hours per year and electricity costs $0.08 per kWh, the annual operating cost for Fan A would be calculated as follows:

Cost=(24,000cfm/15.3cfm/W*(1kW / 1000W)*4000hrs*$0.08/kWh

Completing the math gives an annual operating cost of $508 for Fan A. Using the same formula, annual operating cost for Fan B, is $380. A comparison of operating cost results for the two fans is shown in Table 2.

For a complete comparison, we need to look at the operation of all 10 fans. Since ventilation fans usually operate in stages, all fans in the barn will not have the same operating time. As a simple illustration, it is assumed half the fans operate 4000 hours per year while the other half operates 2500 hours per year. Obviously, the more that is known about expected fan operations, the better the operating cost estimate will be. Given our operating time assumption, the annual operating cost for all 10 fans is given in Table 3. We see a building outfitted with Fan A, the one that saves $3,000 on the initial purchase, will cost over $1,000 per year more to operate than a building outfitted with Fan B. In just 3 years of operation, the electrical energy savings from Fan B will more than offset the higher initial purchase price. For the remaining life of the fan, which could be 10 years or more, the owner is saving money every time the fan runs.

The Bottom Line

It's really not a surprise. Like many other things, buying the cheapest fan isn't always the greatest choice in the long run! And picking a fan based on diameter, motor horsepower, or even on the airflow performance alone may not lead to the wis-

TABLE 2.
Projected annual energy use and operating costs for two 48-inch fans

FAN	CFM	CFM / WATT	kWh	ANNUAL COST
A	24,300	15.3	6353	$508
B	24,200	20.4	4745	$380

ANNUAL DIFFERENCE = $128 per fan (based on 4000 hrs/yr @ $0.08/kWh)

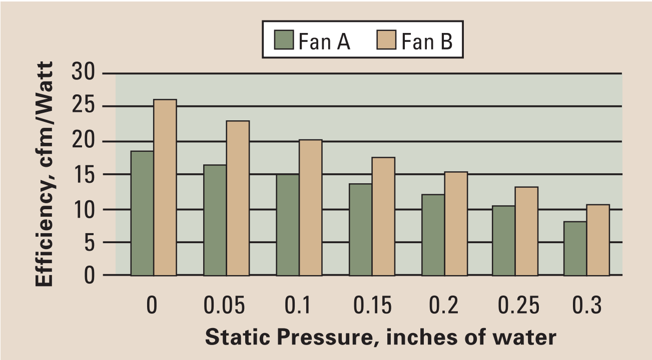

Figure 3. Fan efficiency for two brands of 48-inch, belt drive ventilation fans

est selection. The best bet is to consider only rated (or tested) fans that have performance data available from a certified laboratory. Fan data will be most useful when the tests include all of the equipment and accessories (shutters, guards, etc.) to be installed in the proposed application. Test data should cover the range of static pressures that would be expected during normal operations.

With test data in hand, look at several fans that fit your application and use the following criteria to make a selection:

- Airflow delivered at desired static pressure
- Energy efficiency (cfm/Watt) – stick to the suggested VER guidelines
- Durability & quality of materials & construction
- Dealer service
- Cost

In most cases, applying all of these criteria will lead to fans that provide good ventilation and reliable, cost efficient service for the life of the fan. And those are some ingredients to help make happy customers!

For more information:

1) Selecting Rated Ventilation Fans. 1996. Eileen F. Wheeler. Agricultural and Biological Engineering Extension, The Pennsylvania State University, University Park, PA, 16802. Web published at http://www.abe.psu.edu/extension/factsheets/g/G85.pdf.

2) Selecting Tunnel Ventilation Fans. 2002. Eileen F. Wheeler. Agricultural and Biological Engineering Extension, The Pennsylvania State University, University Park, PA, 16802. Web published at http://www.abe.psu.edu/extension/factsheets/g/G103.pdf.

3) Guidelines for Selection of Energy Efficient Ventilation Fans (EP 566). 2001. American Society of Agricultural & Biological Engineers, 2950 Niles Rd., St. Joseph, MI, 49085. (Available to NFBA members in the ASABE Technical Library at http://www.asabe.org).

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TABLE 3.
Projected annual cost to operate 10 fans from two different manufacturers

FAN OPERATIONS	FAN A	FAN B
5 fans@4000hr	$2,540	$1,900
5 fans@2500 hr	$1,588	$1,188
Annual Total	$4,128	$3,088